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Jerzy MICHAŁOWSKI

Studies on species characters in *Bombina variegata* (L.) and *Bombina bombina* (L.).

I. Applying the L:T indicator to the classifying purposes

Studia nad cechami gatunkowymi kumaków *Bombina variegata* (L.) i *Bombina bombina* (L.).

I. Zastosowanie wskaźnika L:T dla celów klasyfikacyjnych

Исследования видовых признаков жерлянок *Bombina variegata* (L.) и *Bombina bombina* (L.).

Применение показателя L:T в классификационных задачах.

INTRODUCTION

On territories where both European species of *Bombina* cover themselves a very considerable number of individuals are being found exhibiting an immixture of characters of the other species sometimes even so considerable as to make difficult their correct classification. It becomes then necessery to look for a number as great as possible of reliable species characters of a fixed degree of importance which a classification could be rested on. As yet the taxonomic systems (HORBULEWICZ, 1927, MICHAŁOWSKI, 1958, STUGREN, 1959) were based merely on some characters of dye and on the structure of the skin nipples. It seems therefore in time to take in account other

date e. g. biometric ones and this is justly the aim of the following researches.

The differences in structure of the body occuring between the studied species are obvious even in a superficial observation of typical forms. Among others SCHREIBER (1912) refers to them drawing attention for instance to the occurence of longer back extremities in *Bombina variegata* (L.), TERENTEV and ČERNOV (1949) also describe these differencies, reporting in the same time the most important biometric indicators for both species of *Bombina*. Alas in consequence of a strong individual variability in *Bombina* species the ranges of variability in majority of indicators cover themselves to a considerable extent. The attention is most worth being drawn to the indicator of the relation between the length of the body and that of the thigh (L:T) of which valour the above mentioned authors report as follows: for *Bombina variegata* (L.) 2,28—3,09, and for *Bombina bombina* (L.) 3,06—3,33.

STUGREN (1959) tried to apply this indicator to classifying purposes but it was in vain as he obtained contradicting results. Likewise the author (1958) obtained, too, especially for the intermediate sphere, vague date and often contradicting with in a given case indisputable classification results. Supposing however that the reason of failures lay in a wrong choice of material the investigations were undertaken anew.

MATERIAL AND METHOD

In the work it has been taken use of the material previously collected (MICHAŁOWSKI, 1958, 1960) on territory of the Cracow district. 1219 samples were considered in all. For the sake of comparison extra 16 samples of lowland and 26 those of mountainous *Bombina* from Czechoslovakia were used of which biometric data have kindly been sent to me by Mr. J. LÁC from Bratislava. I thank him here ever so much for them. Measurements by means of compasses were performed on recently killed samples, from the obtained results the average valours of the L:T indicator have been calculated for particular posts and they were brought upon a map. In addition to it the ma-

Specification I

The most important data of the L:T indicator valours in studied Bombinators samples

Species	Class	I.			II			III		
	Body length in mm	20—29	30—39	40—	20—29	30—39	40—	20—29	30—39	40—
Bombina variegata (L.)	Pieces	8	173	436	1	32	79	4	17	39
	Range of variability		2,21—2,75	2,28—3,07		2,29—2,69	2,24—2,97		2,27—2,82	2,44—3,06
	Arithmetic mean	2,48	2,43	2,59	2,50	2,49	2,64	2,47	2,49	2,74
	Standard deviation of the mean		±0,15	±0,14		±0,11	±0,15		±0,13	±0,18
	Standard error of the mean		0,01	0,07		0,02	0,02		0,03	0,03
Bombina bombina (L.)	Pieces	20	69	132	9	22	72	8	33	44
	Range of variability	2,41—2,81	2,46—3,04	2,50—3,24		2,52—3,16	2,56—3,34		2,48—2,88	2,56—3,16
	Arithmetic mean	2,59	2,70	2,88	2,55	2,74	2,91	2,63	2,70	2,87
	Standard deviation of the mean	±0,08	±0,10	±0,13		±0,16	±0,15		±0,09	±0,14
	Standard error of the mean	0,02	0,01	0,01		0,03	0,02		0,02	0,02
Median form (cl. IV)	Pieces	3	12	16						
	Range of variability		2,46—2,96	2,62—3,04						
	Arithmetic mean	2,67	2,63	2,80						
	Standard deviation of the mean		±0,16	±0,13						
	Standard error of the mean		0,05	0,03						

terial was considered and divided into groups according to classes (in accordance with the MICHAŁOWSKI'S division (1958)) and the latter in turn were divided into subgroups according to the body's length. The material was elaborated in the statistical way, such indicator valours being enumerated as arithmetical means, ranges of variability, standard deviations of the means, standard errors of the means, correlation coefficient, significance of arithmetic means differences. The presence of 10 pieces at least in each group was the condition of performing calculations.

RESULTS

There was calculated the significance of arithmetic means differences of the L:T indicator between the individuals of *Bombina* of the same species and the same class and differing among them varying in their body length (vid. specification I.). These differences are in all cases statistically significants (at P = 95%).*

Specification II

Median L:T indicator valours in Bombinators deriving from Czechoslovakia

Species	Body length	20—29 mm	30—39 mm	40— mm
Bombina variegata (L.)	Pieces		25	1
	Arithmetic mean		2,54	2,68
Bombina bombina (L.) from lowland	Pieces	1	6	2
	Arithmetic mean	2,76	3,01	3,13
Bombina bombina (L.) from intermediate zone	Pieces		5	2
	Arithmetic mean		2,82	2,95

* It was calculated on the basis of the model:

$$t = \frac{x_1 - x_2}{\sqrt{m_2^1 + m_2^2}}$$

Specification III

Significance of differences among median L:T indicator valours in particular Bombinators classes. *

	Bombina variegata (L.) cl. I	*Bombina variegata* (L.) cl. II	*Bombina variegata* (L.) cl. III	Median form	*Bombina bombina* (L.) cl. III	*Bombina bombina* (L.) cl. II	*Bombina bombina* (L.) cl. I
Bombina variegata (L.) cl. I		— **	—	+	+ ***	+	+
Bombina variegata (L.) cl. II	—		+	+	+	+	+
Bombina variegata (L.) cl. III	—	+		—	+	+	+
Median form	—	+	—		—	+	+
Bombina bombina (L.) cl. III	+	+	+	—		—	—
Bombina bombina (L.) cl. II	+	+	+	+	—		—
Bombina bombina (L.) cl. I	+	+	+	+	—	—	

* It was calculated on the basis of the model: $t = \frac{x_1 - x_2}{\sqrt{m_1^2 + m_2^2}}$. Samples of body length from 40 mm upwards were taken for calculations

** The difference not significant.

*** The difference significant.

The correlation coeficient was calculated between L:T indicator valours and particular *Bombina* classes. It amounts to 0,61; then it's a high correlation **.

The above specifications and the map allow of following conclusions:

1. Distinct differences among particular *Bombina* groups occur in the median arithmetic L:T indicator valours. In accordance with previsions (except for one case) the median indicator valours are lower in more mountainous form, and higher in those from lowland ones. The median forms (class IV) are in the middle position. (Specification I).

2. The arithmetic means data of the L:T indicator are lover in younger (smaller) indicidulas of the same class. These differences are in all groups statistically significants.

3. Similar phenomina like in items 1 and 2 occur among the *Bombina* from Czechoslovakia.

4. The median L:T indicator valours of the all classes of both species (specification III) differ each from another in a significant way. Within one species (except for ond case) no statistically significant differences occur. The median valours (the arithmetics means) of the intermediate forms and of the third classes indicator show no significant differences with reference to remaining median groups.

5. Median valours of the L:T indicator calculated for positions show systematic increasing in dependence upon the passage from mountainous to these of lowland positions (Map).

DISCUSSION

The results of these investigations are in part in contradiction with the present data, which is probably due to differences in the choice and quantity of the material. TERENTEV and ČERNOV (1949) based upon the data taken from USSR territories, which constitute a part of the area of the typical lowland Bombinator. The even typical samples of the lowland

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** It was calculated on the basis of the model:

$$r = \frac{\Sigma(x-\bar{x})\,(y-\bar{y})\,1}{\sqrt{\Sigma(x-\bar{x})^2\,1x\,\Sigma(y-\bar{y})^2 1x}}$$

Samples of the body length from 40 mm upwards were taken for calculations.

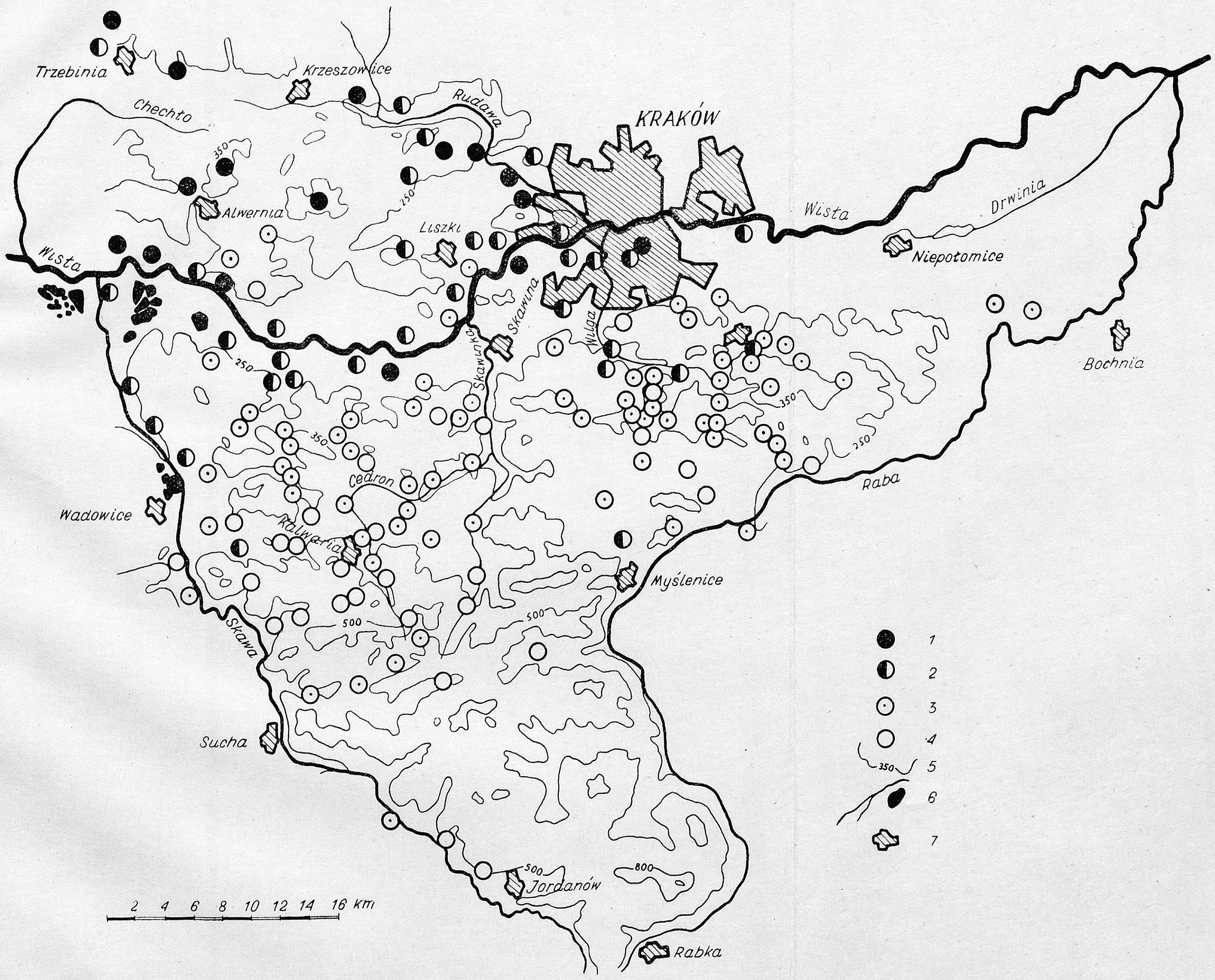
Bombinator investigated in this work come from areas lying on the boundaries of both species, from the intermediate territories in geographical and faunal viewpoint. Hence certainly comes the considerable lowering of the lower boundary of oscillations in the L:T indicator valour in the investigated material. The data from Czechoslovakia regarding the lowland Bombinator from the lowlands and from the intermediate territories fully con firm this suposition. The indicator valours obtained for the mountainous *Bombina variegata* (L.) cover almost entirely with those of Terentev and Černov (1949). The full accordance in the height of the absolute indicator valours is found also with reference to the Stugren's data (1959), and varying conclusions as to the possibility of applying them to the classifying purposes are certainly due to a too small number of individuals used by this author (81 individuals of both species representing as many as 8 different biotopis types). One is however to agree with his opinion that it is difficult to establish a sharp boundary among the species on this basis of biometric data. Taking in account the median indicators valour (the arithmetic means) we state in the here described material that the intermediate forms do not differ in a significant way from the third classes: of both species forming some kind of bridge among them (Specification III).

The enclosed map illustrates the possibility of applying the median indicator valours to the estimation of positions.

For the previously studied geographical dislocations of Bombinators on this territory (Michałowski 1958, 1959, 1960) are characteristic: a) prevalence of *Bombina variegata* (L.) in the mountains and in the hills running along them, b) its fore-posts in the Vistula valley, e. g. in Kłaj and Stanisławice, c) its insular occurence in the south part of the Cracow-Chrzanów Hillback and on the part of the Vistula valley adjoining to it. d) prevaling posts of the *Bombina bombina* (L.) in the Vistula valley and on the territory of the Cracow—Chrzanów Hillback, e) its invasion to the south along the valleys of Skawa and Wilga.

As it is evident on the map the median amounts of the L:T indicator calcilated for particular posts confirm the above observations, the valour limit being 2,75.

A question arises whether in spite of the lack of a sharp



Map. Dislocations of the median L:T indicator valours on the examined territory

1 — post of median valour 2,95—2 — post of median valour 2,75—2,94, 3 — post of median valour 2,55—2,74, 4 — post of median valour 2,35—2,54. 5 — layers, 6 — rivers and lakes, 7 — places.

boundary between indicator valours for both species they could not be applied to the estimation of the particular samples, as the connection exists between the median L:T indicator valour and the class of Bombinator, the accordance of data taken from the territory being established. For this question to be answered 50 typical samples of lowland Bombinator were picked in alphabetical order of posts, of body length from 40 mm and a curved line of the variability of the indicator was traced. It turned out that the limit valour of the L:T indicator being looked for was to some extent 2,80. Lower valours than this have been found in 12 Bombinators, higher in 38, just from 2,80 a rapid uprise of the curved line having been observed. Owing to this the L:T indicator should be applied to the classification purposes and 2,75 for the post and 2,80 for the sample should be adopted as limit valours, provided that these valours should be valid only on the intermediate territories. The work should be performed only on samples of form 40 mm upwards of the body length, as in smaller ones the back extremities are relatively longer, therefore lower indicator valours are being obtained. For instance the contradicting data formerly obtained (MICHAŁOWSKI, 1958) were due to the that on some posts, especially in typical lowland samples of *Bombina bombina* (L.) young samples were caught, and median indicator valours calculated for them showed a conspicuously mountainous character of the post. There is also being suggested to punctuate, on account of the heterogeneity of results, the height of the indicator as the tertiary character (1 point), which after all leads to a new classification system that com prises 7 pairs of characters with the maximal number of points, namely 13. To the first class should be counted samples getting 13 and 12, 11 points, to the second 11,10 points, to the third 9,8 points, to the 7,6 points. The system formulated in this way in not definitively finished. It should be enlarged by eventual applying further biometrical data for classifying purposes, as well as characters taken in figures such as: colour of finger tips, separate or collective occurence of spots on the soles of extremities and under throat, and so on...

Silesian Academy of Medicine
Department of General Biology.

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STRESZCZENIE

W celu opracowania zastosowalności wskaźnika L:T (stosunek długości ciała do długości golenia) dla celów klasyfikacji kumaków górskich *Bombina variegata* (L.) i nizinnych *Bombina bombina* (L.) oraz form pośrednich (kl. IV) przebadano 1219 okazów obydwu gatunków, zebranych z południowej części województwa krakowskiego. Stwierdzono, że przy istniejącym związku między średnią wysokością wskaźnika i klasą kumaka (ocenioną wg klasyfikacji Michałowskiego, 1958) i przy zgodności średnich wartości wskaźnika poszczególnych stanowisk z ich dotychczasową oceną zoogeograficzną jest możliwe zastosowanie wskaźnika L:T do celów taksonomicznych. Wykazano, że stanowiska, dla których średnie wartości wskaźnika złowionych w nim okazów wynoszą co najmniej 2,75, mogą być uważane za stanowiska o przewadze kumaków nizinnych, zaś przy ocenie poszczególnych okazów należy przyjąć jako wartość graniczną wskaźnika dla kumaka nizinnego 2,80, z tym że wspomniane wartości mają moc obowiązującą tylko w terenach przejściowych. Zaproponowano uznać wysokość wskaźnika za cechę trzeciego rzędu (1 punkt), co prowadzi do nowego systemu

klasyfikacyjnego o 7 parach cech i o maksymalnej ilości punktów 13. Do pierwszej klasy należałoby zaliczyć okazy, które uzyskały 13 i 12 pkt., do drugiej 11, 10, do trzeciej 9, lub 8, do czwartej 7, 6.

РЕЗЮМЕ

С целью разработки применяемости показателя Л:Т (отношение длины тела к длине голени) в классификационных задачах у *Bombina variegata* (L.) и *Bombina bombina*, (L.) а также посредних форм (4 кл.), автор подвергнул исследованию 1219 особей обоих видов, собранных в южной части Краковского воеводства. Автор констатировал, что при существующей связи между средней величиной показателя и классом жерлянки (оцененной по классификации Михаловского, 1958), а также при наличности согласия средних оценок показателя отдельных местонахождений с их теперешней зоогеографической оценкой, применение показателя Л:Т, для таксономических задач, возможно. Далее автор констатировал, что местонахождения, для которых средняя оценка показателя найденных там особей равняется 2,75, можно считать как местонахождения с преимуществом *Bombina bombina* (L.) стоянками низменных жерлянок. При оценке отдельных особей, следует применить крайнюю оценку показателя 2,80 для *Bombina bombina* (L.) при условии, что вышеупомянутые ценности имеют обязательную силу только на посредних территориях. Автор предло жил считать величину показателя третьеразрядной приметой (1 пункт). Это ведет к новой классификационной системе, которая охватывает 7 пар примет с 13 пунктами, представляющими их максимальное количество. К первому классу следует причислить особи, получившие 13 и 12 пунктов, ко второму классу — 11,10 пунктов, к третьему — 9 или 8 пунктов, к четвертому 7,6 пунктов.

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